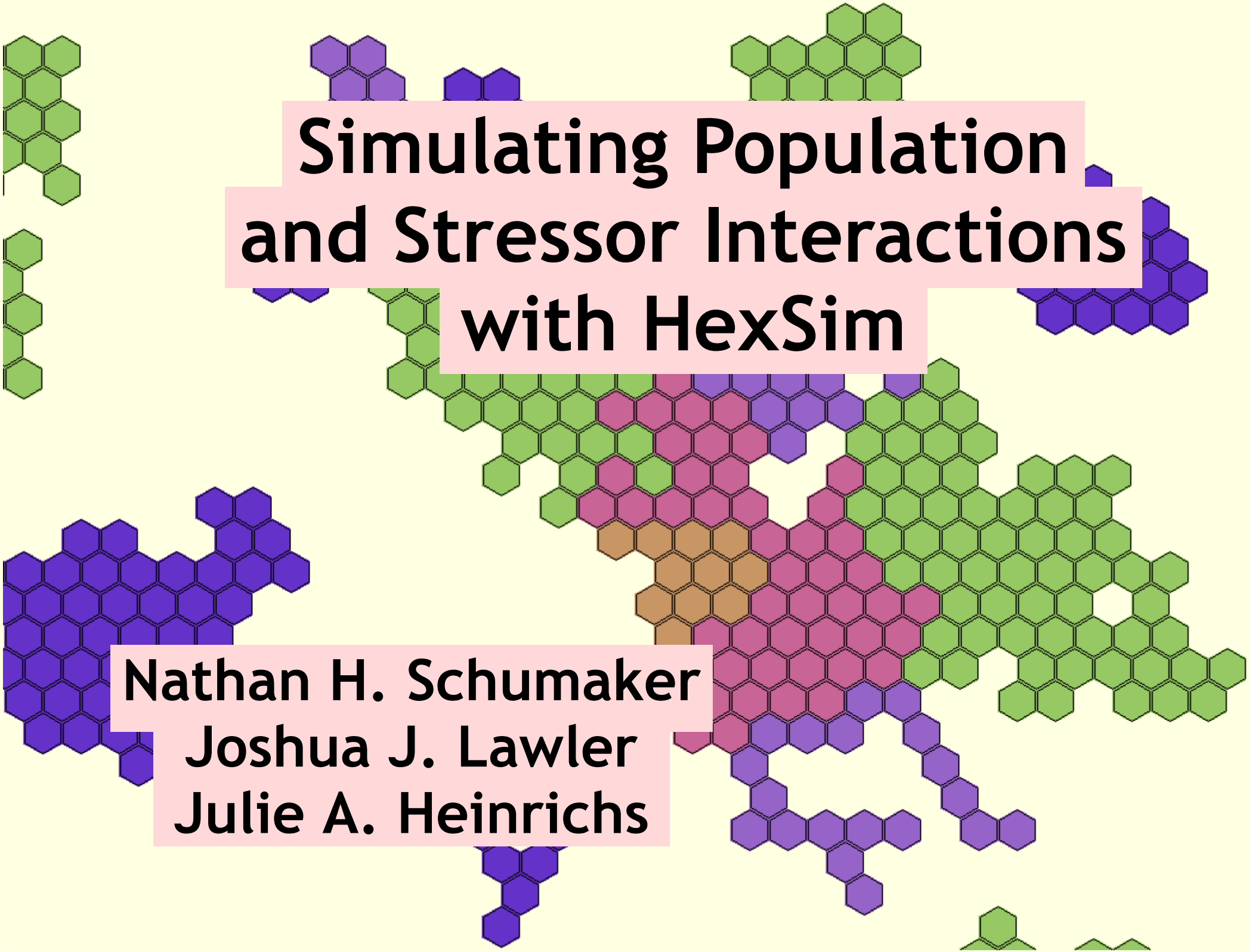
Simulating Population and Stressor Interactions with HexSim



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Introduction

This talk is mostly about methods.

You will be introduced to a new individual-based model (HexSim).

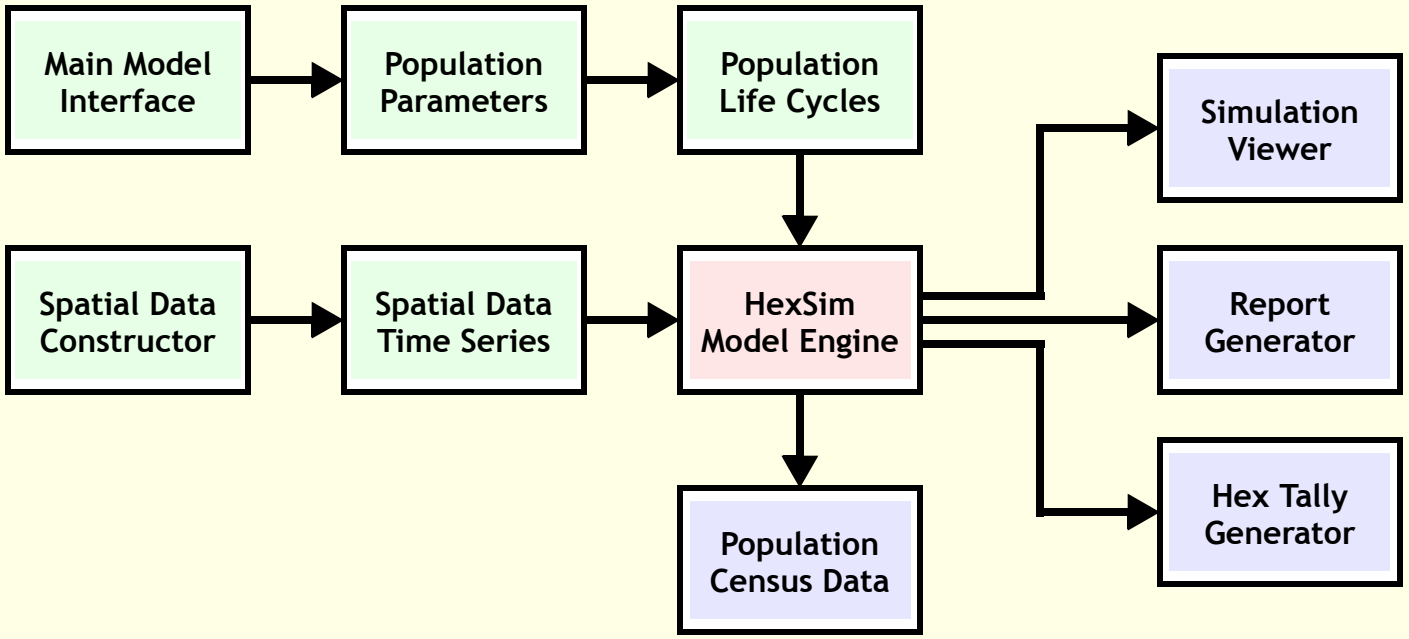
The model can simulate many diverse and complex interacting stressors.

Preliminary results are shown, but this work is a "proof of concept". Realism will be added later.

Thoughts To Take Away

Concepts:	**Questions you might ask with these tools**
Mechanisms:	**How to use the tools to get at the questions**
Expectations:	**The kinds of outputs and insights you can get from the tools**

The HexSim Model



Model Inputs:

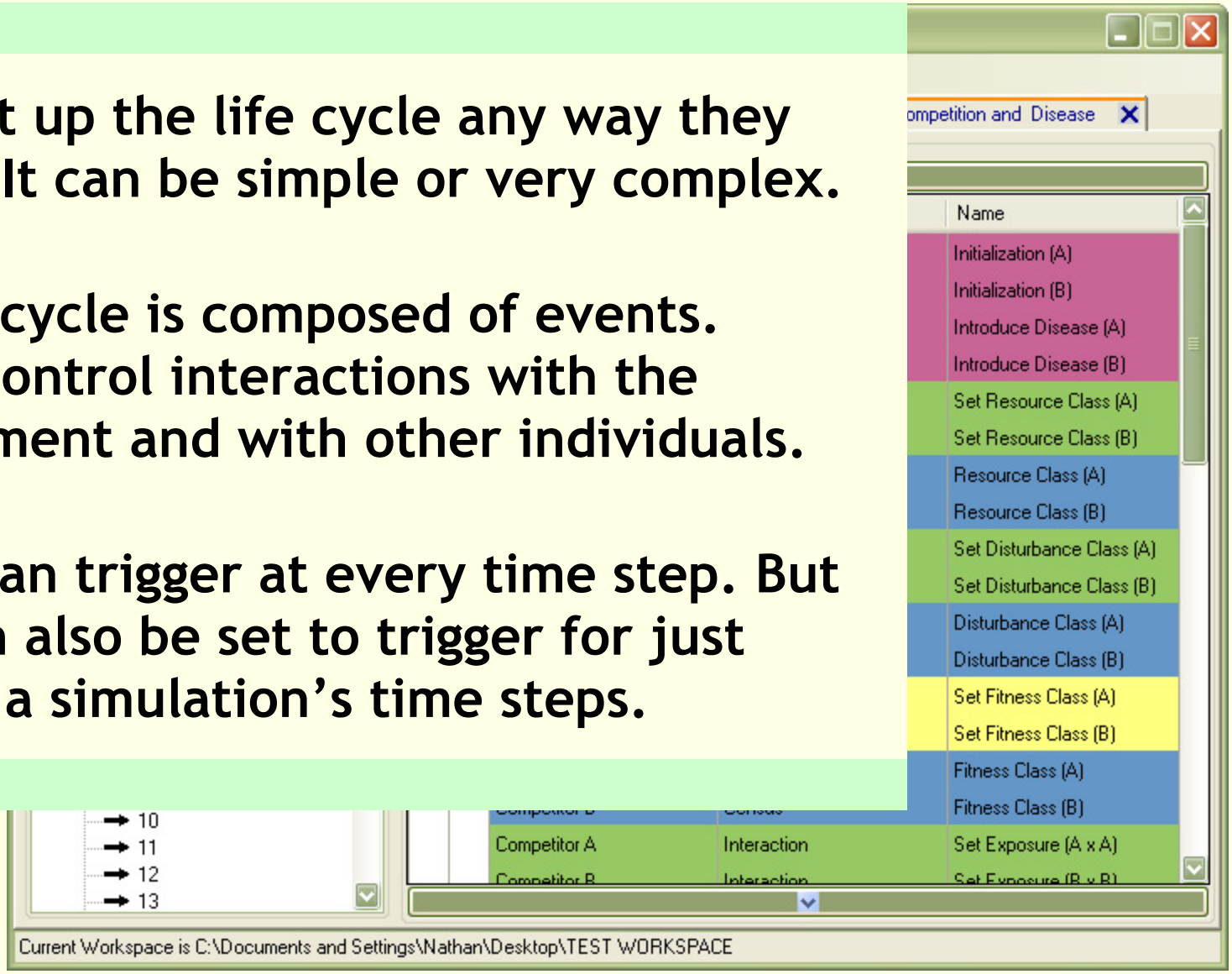
- XML Scenario Data
- Spatial Data

Model Outputs:

- Population Census Data
- HexSim Log File

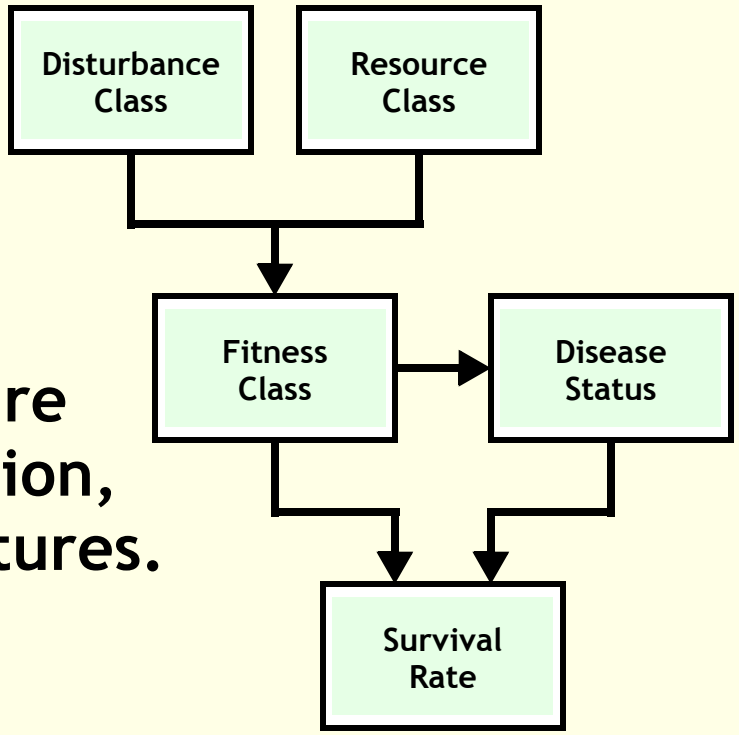
HexSim Life Cycle and Events

- Users set up the life cycle any way they choose. It can be simple or very complex.
- The life cycle is composed of events. Events control interactions with the environment and with other individuals.
- Events can trigger at every time step. But they can also be set to trigger for just some of a simulation's time steps.

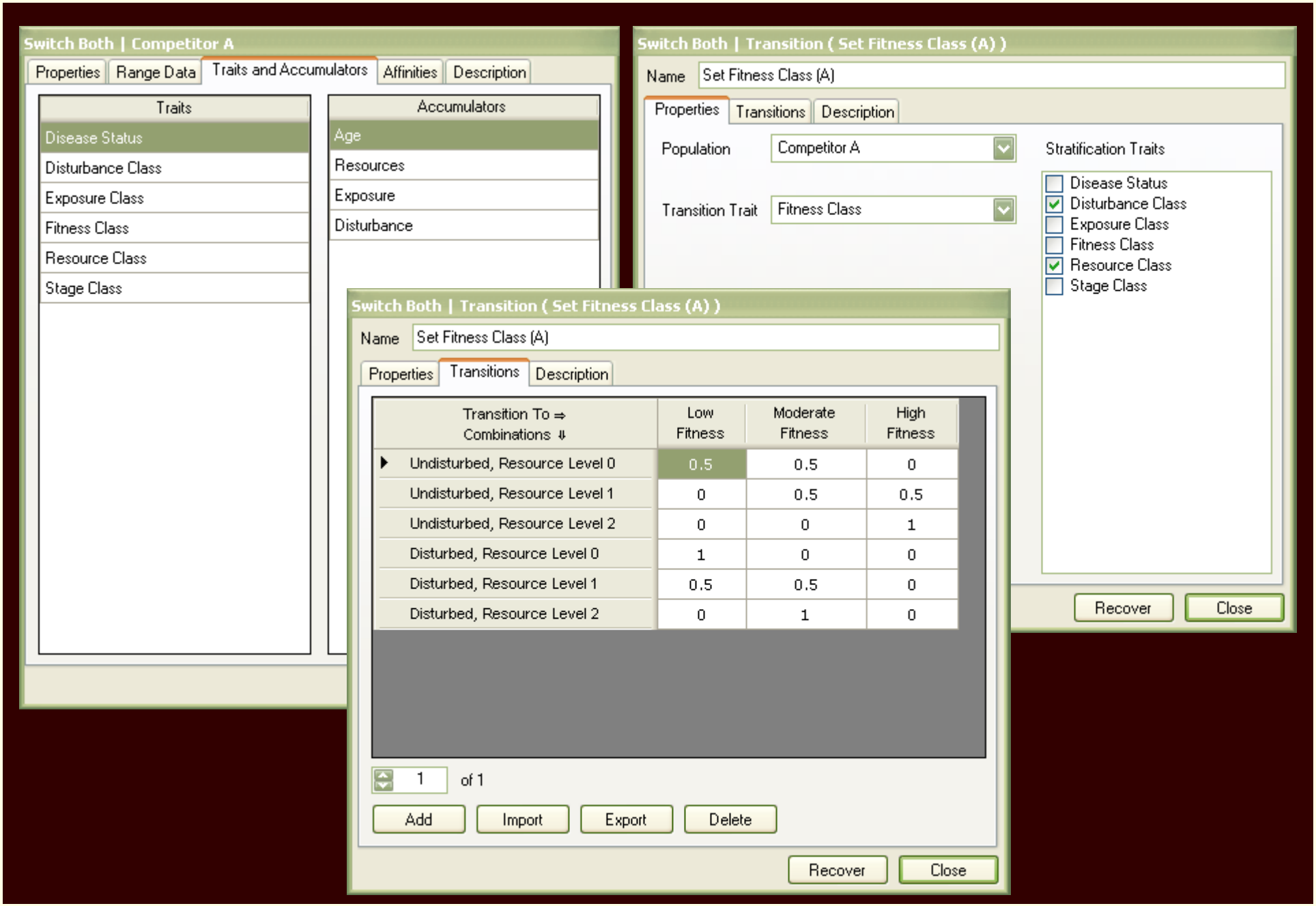


HexSim Traits and Interactions

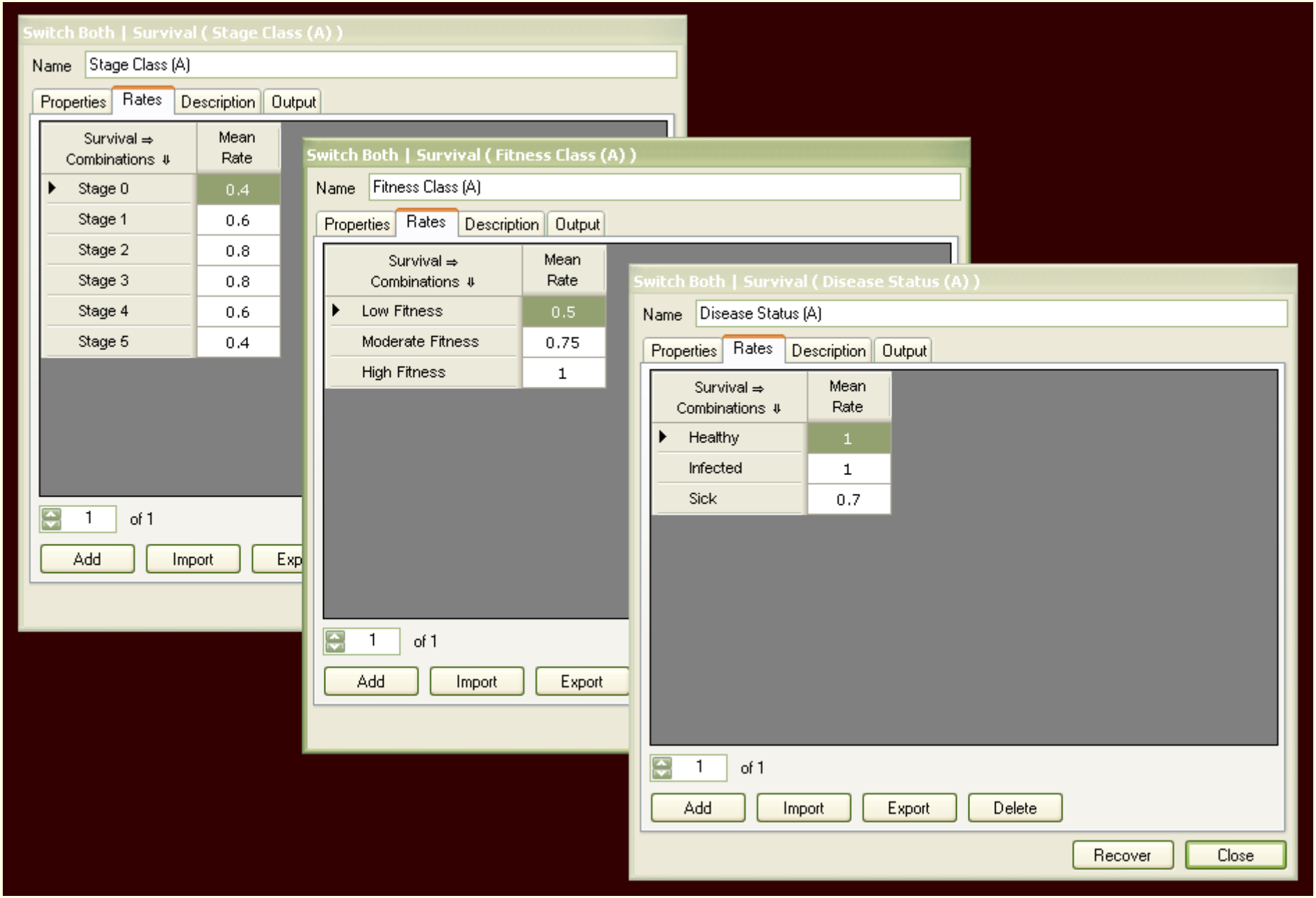
- Traits are tied to the environment, are probabilistic, or are genetic.
- Probabilistic traits can change based on probabilistic and environmental drivers.
- Environmental traits can capture resource acquisition, competition, exposure, and many other features.



Example: Two Traits Control A Third



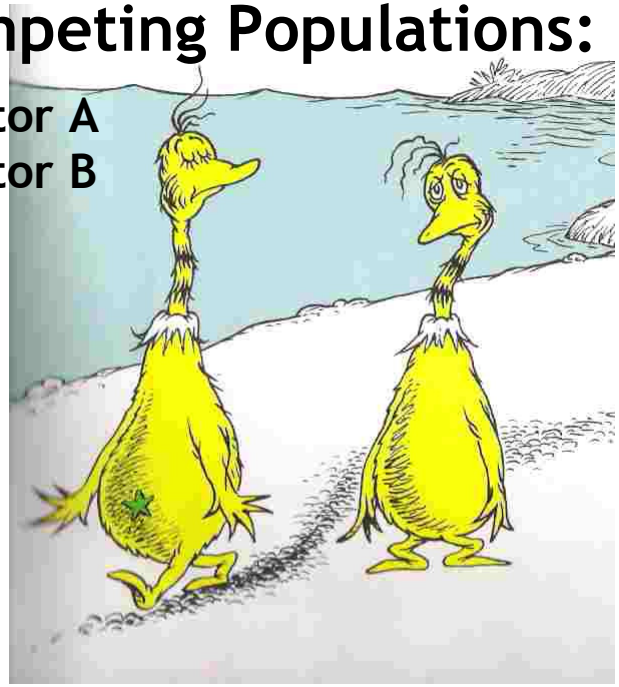
Example: Three Survival Events



Our System Of Interactions

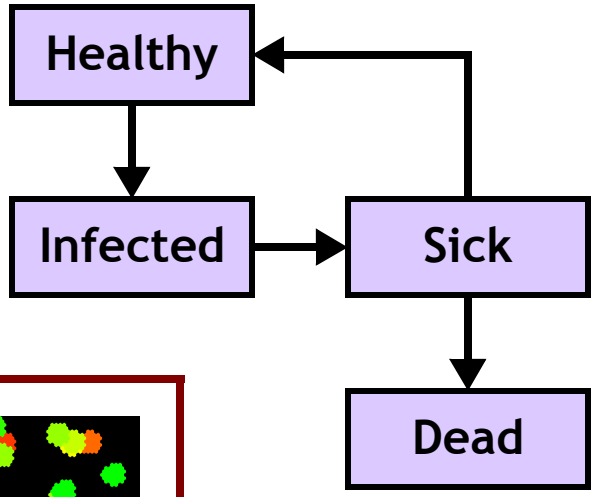
Two Competing Populations:

- Competitor A
- Competitor B



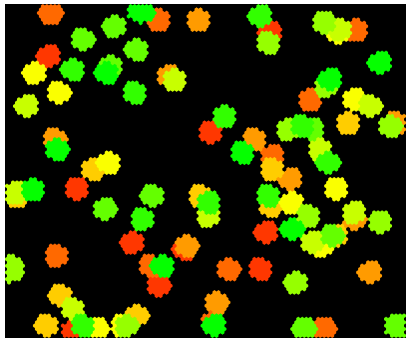
Disease Process:

- Can Spread from A to B, or
- Cannot Spread from A to B

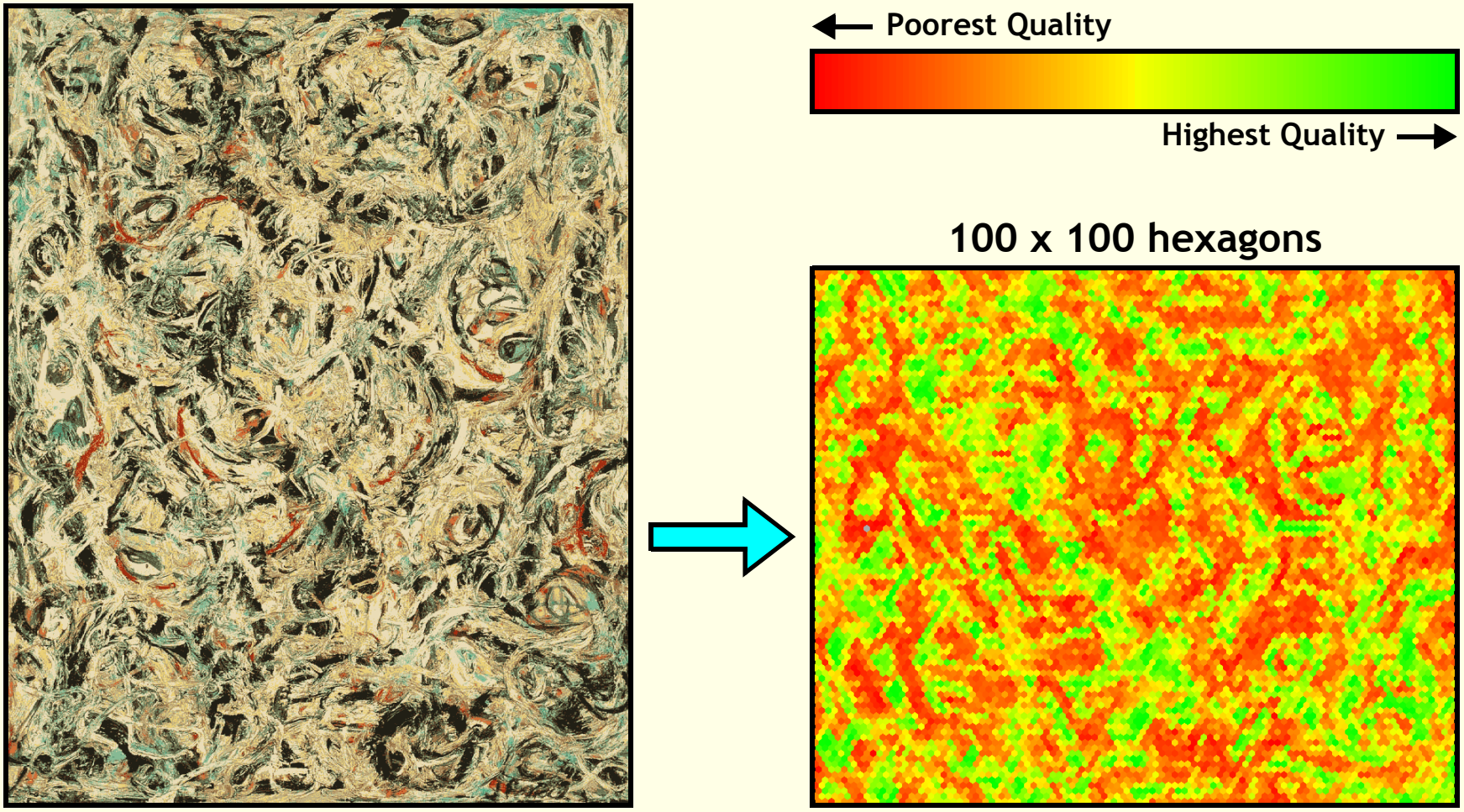


Disturbance Process:

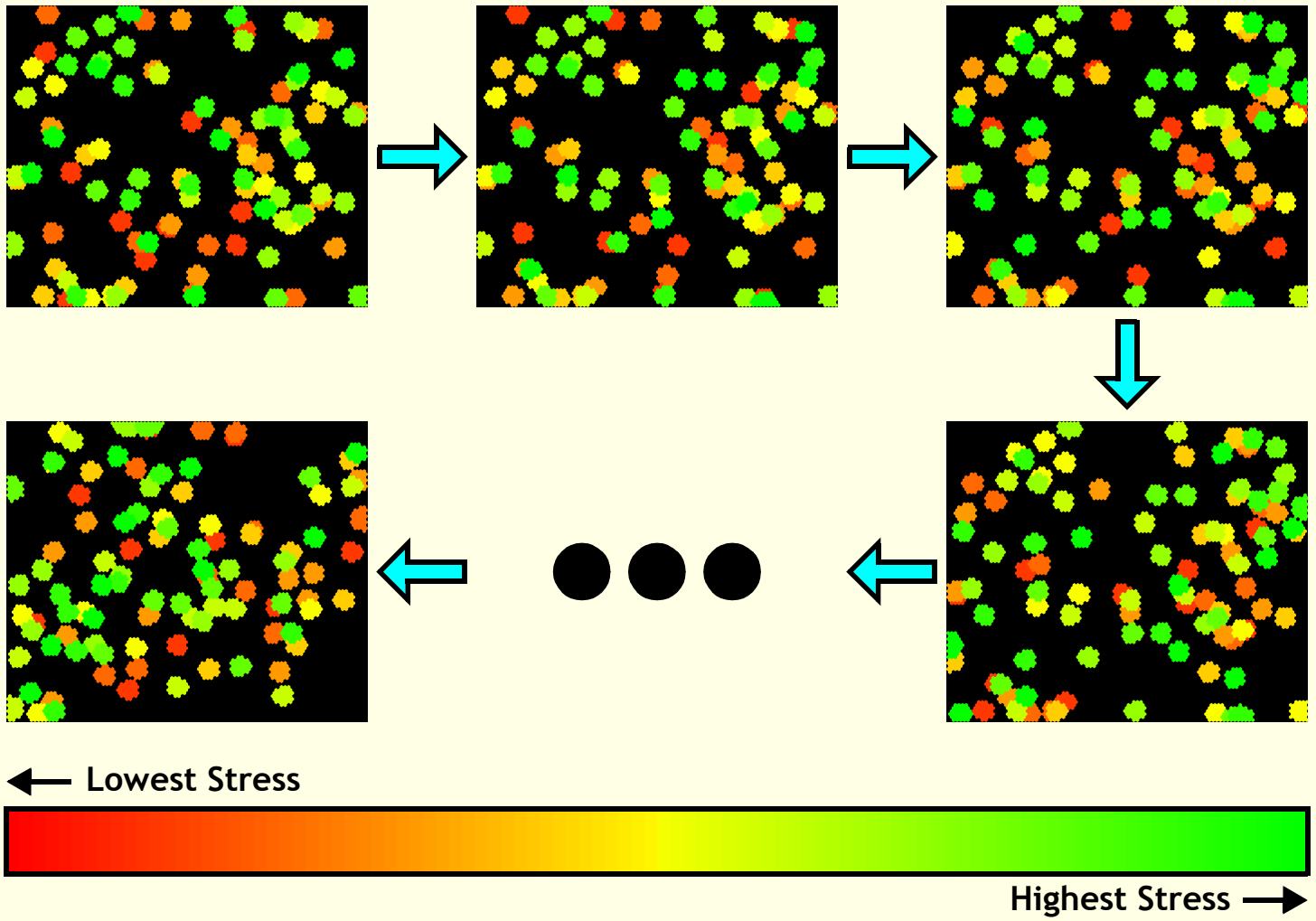
- Dynamic in Space and Time
- Influences Vital Rates



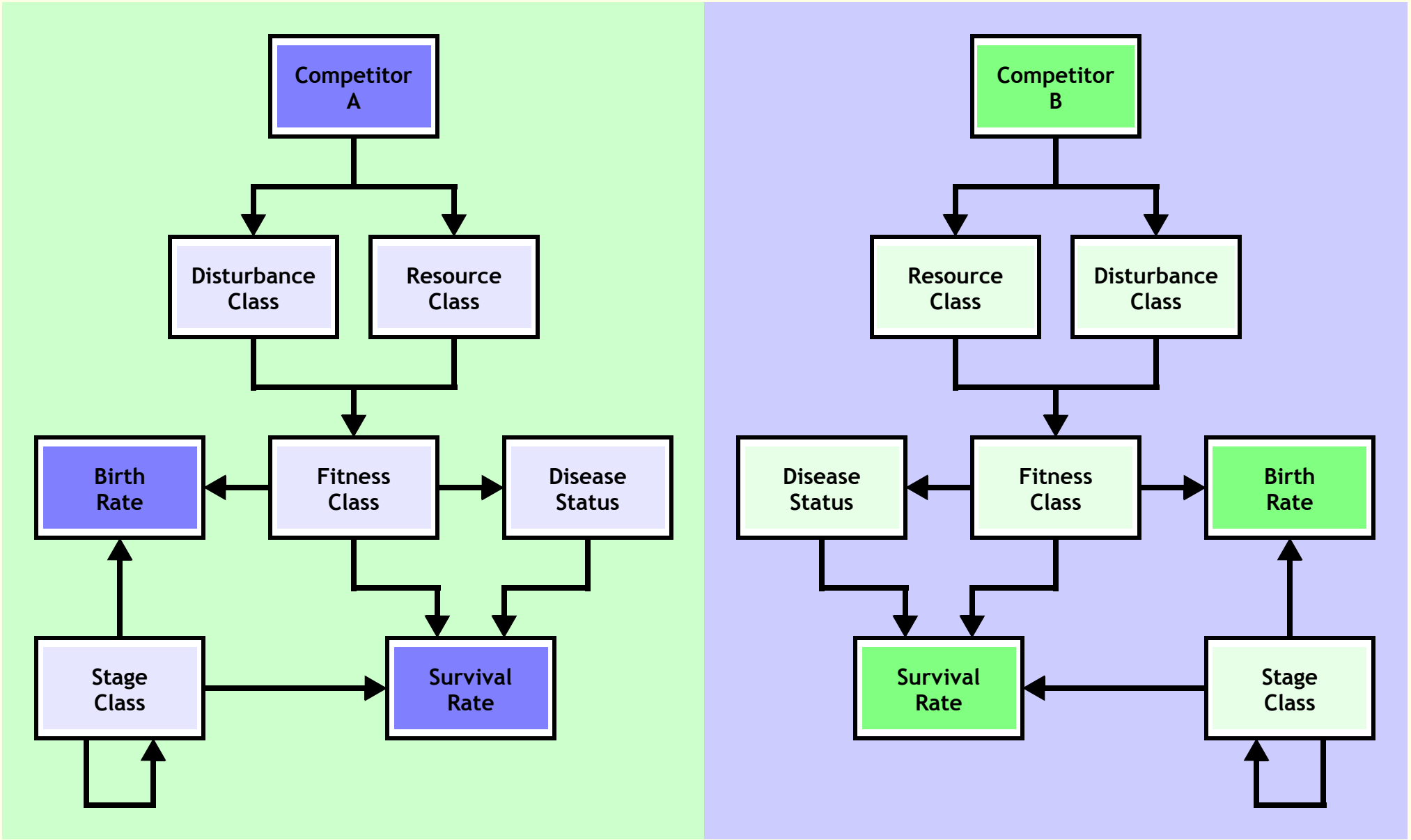
A Single Habitat Map



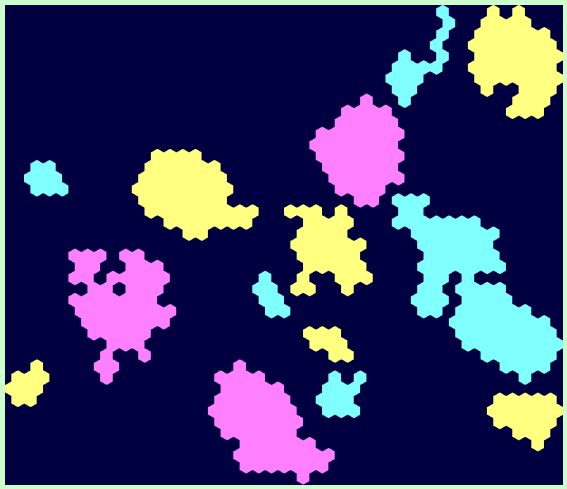
100 Disturbance Maps



Two Competitors



Other Simulation Details



Individuals aggregate into groups of 1-50.

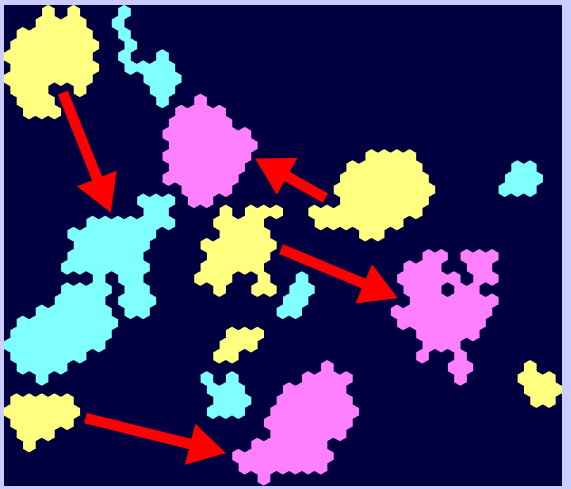
All individuals have equal resource needs.

No environmental stochasticity.

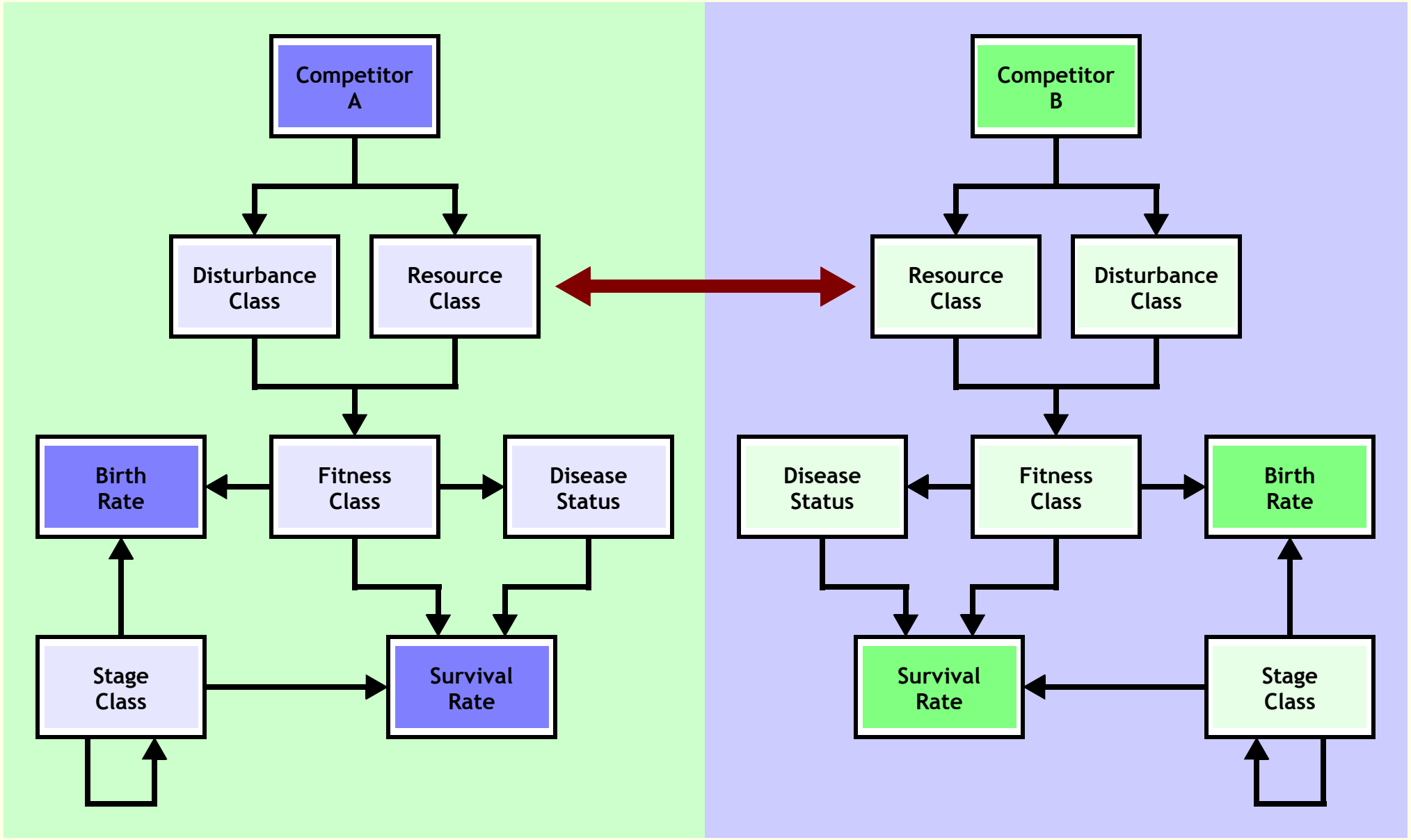
Disease is spread by contact with sick or infected individuals.

Disease has 3 stages: healthy, infected, sick.

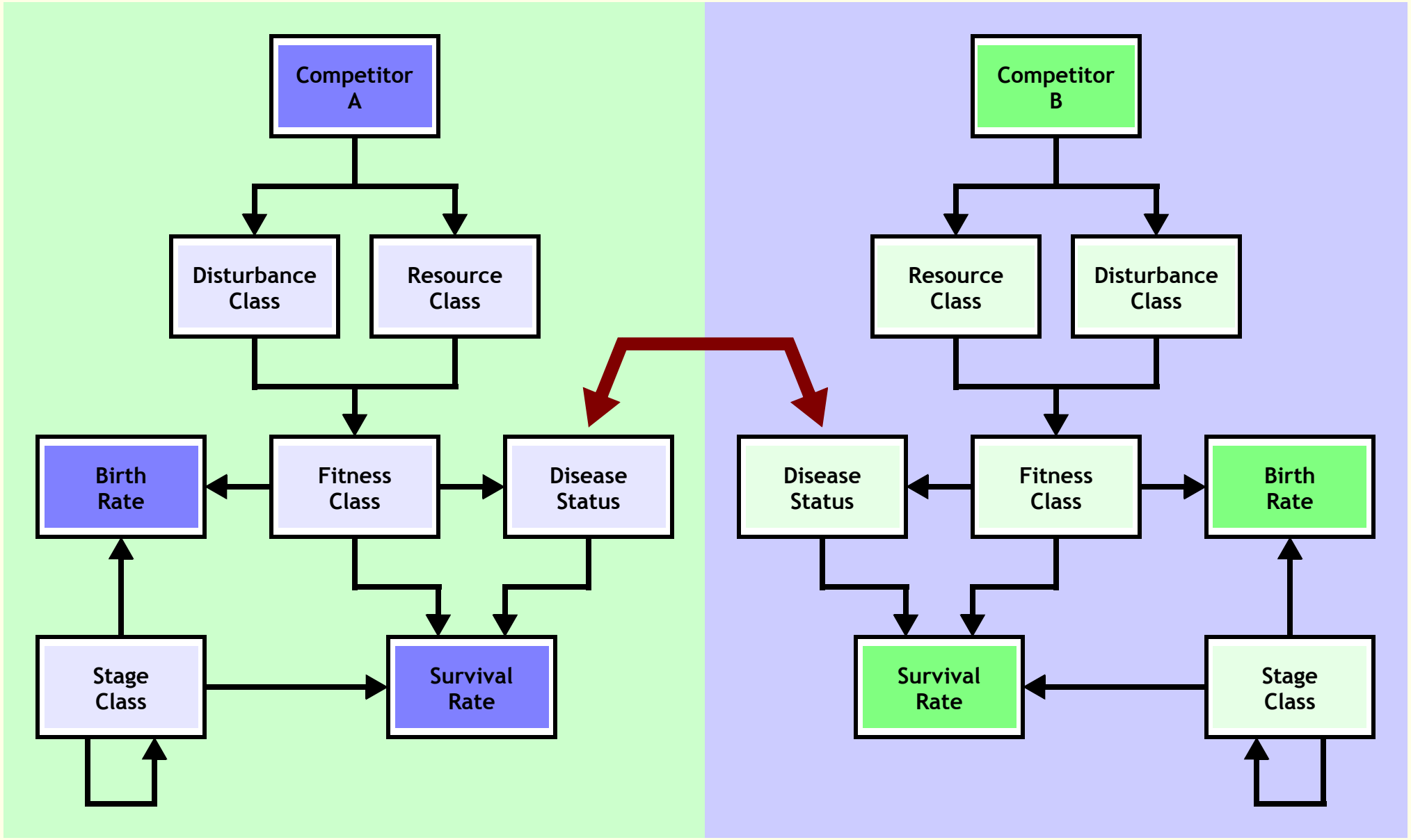
Recovery is fitness-dependent.



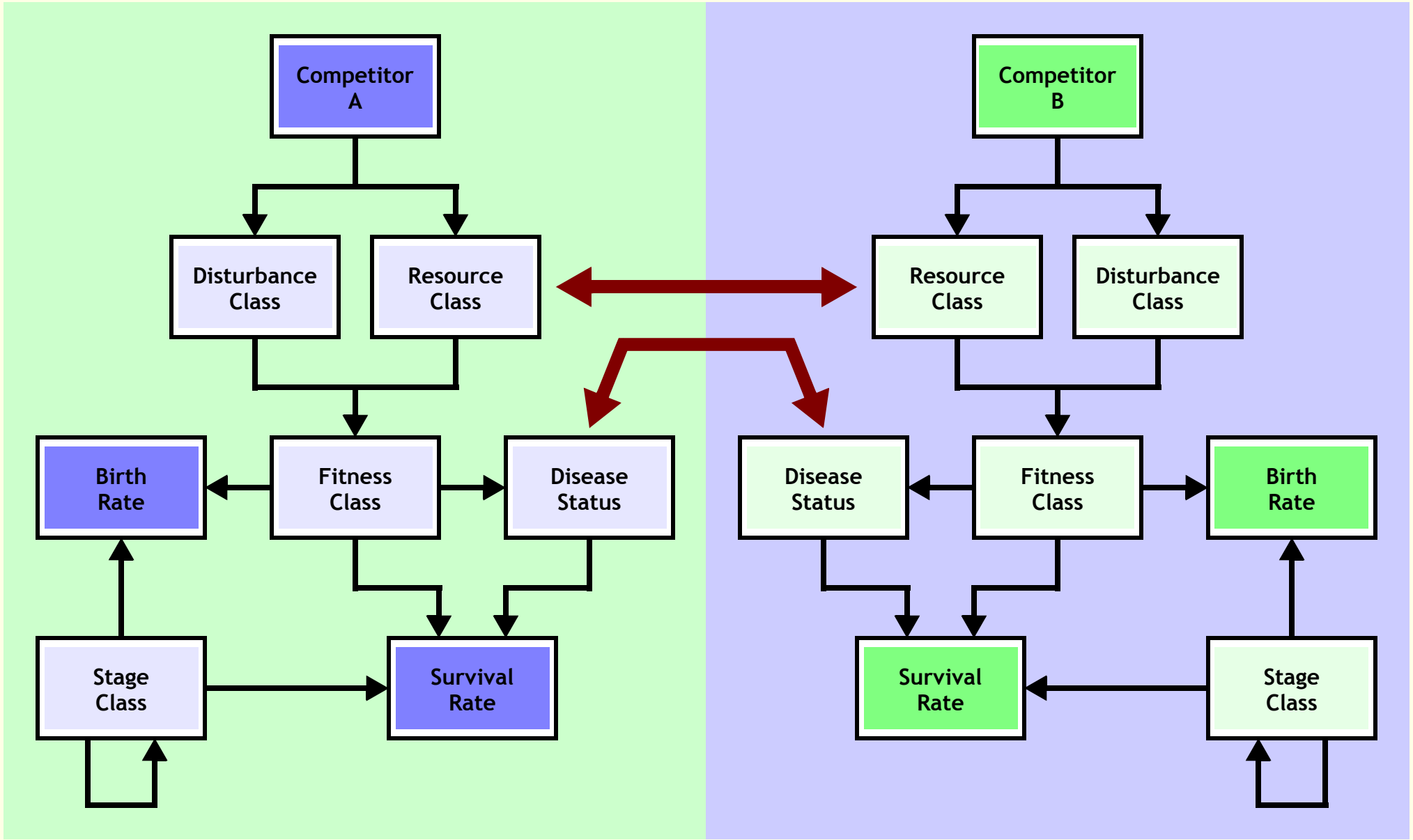
Experiment 1
Add Competition (with / without disease)



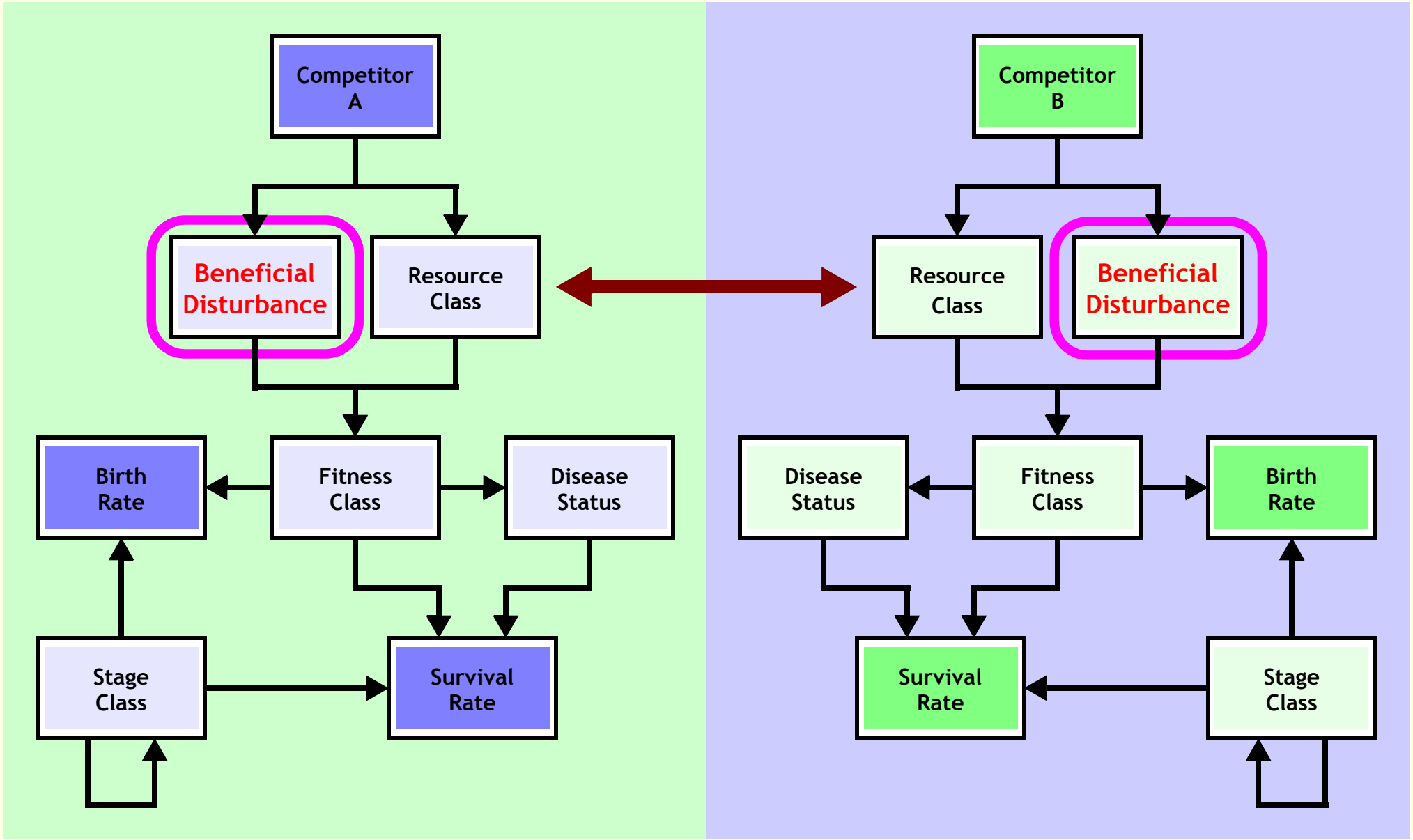
Experiment 2
Add Disease Sharing



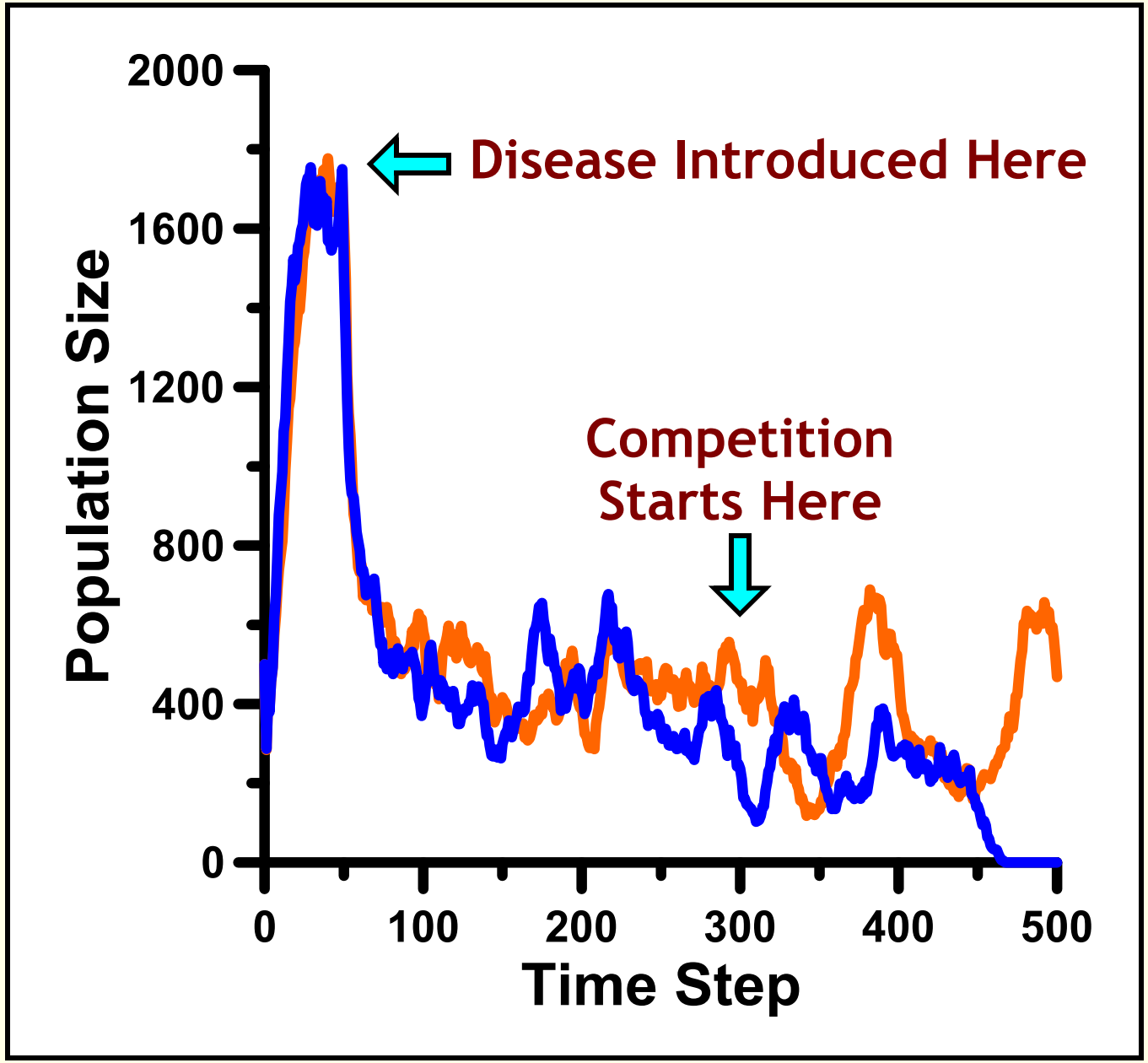
Experiment 3
Add Competition and Disease Sharing



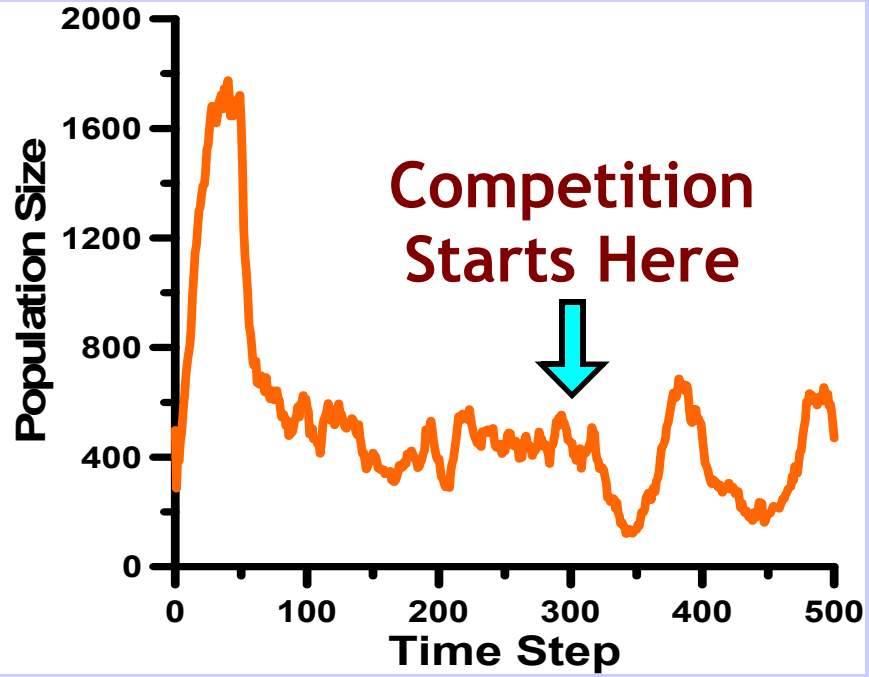
Experiment 4
Add Competition to Beneficial Disturbance

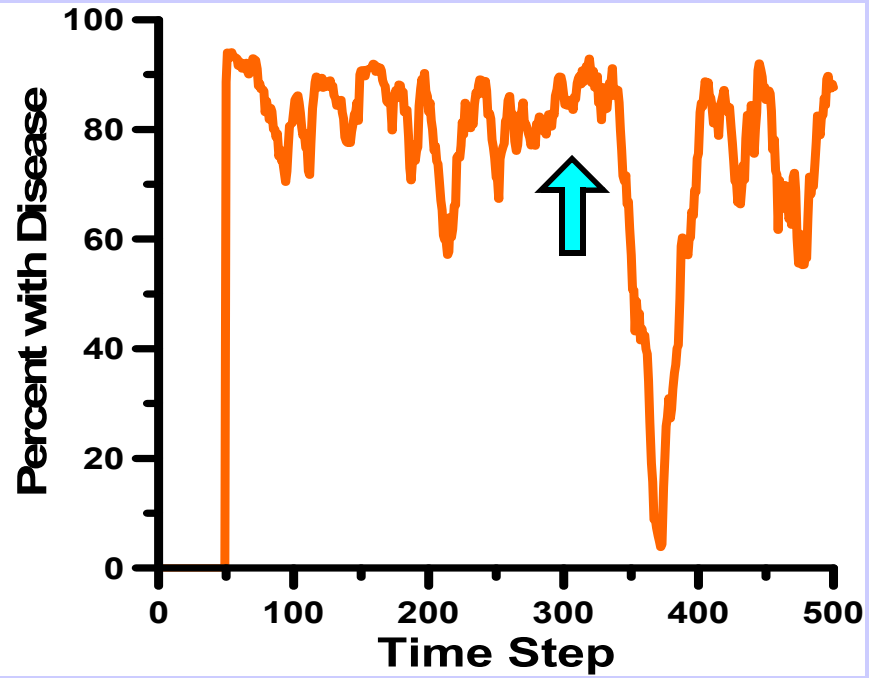


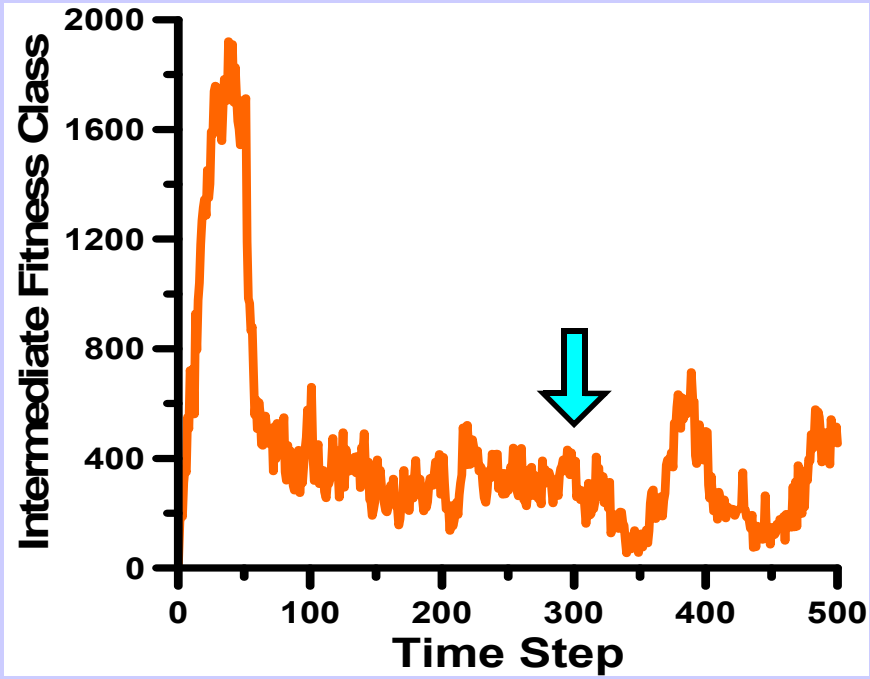
Disease + Competition



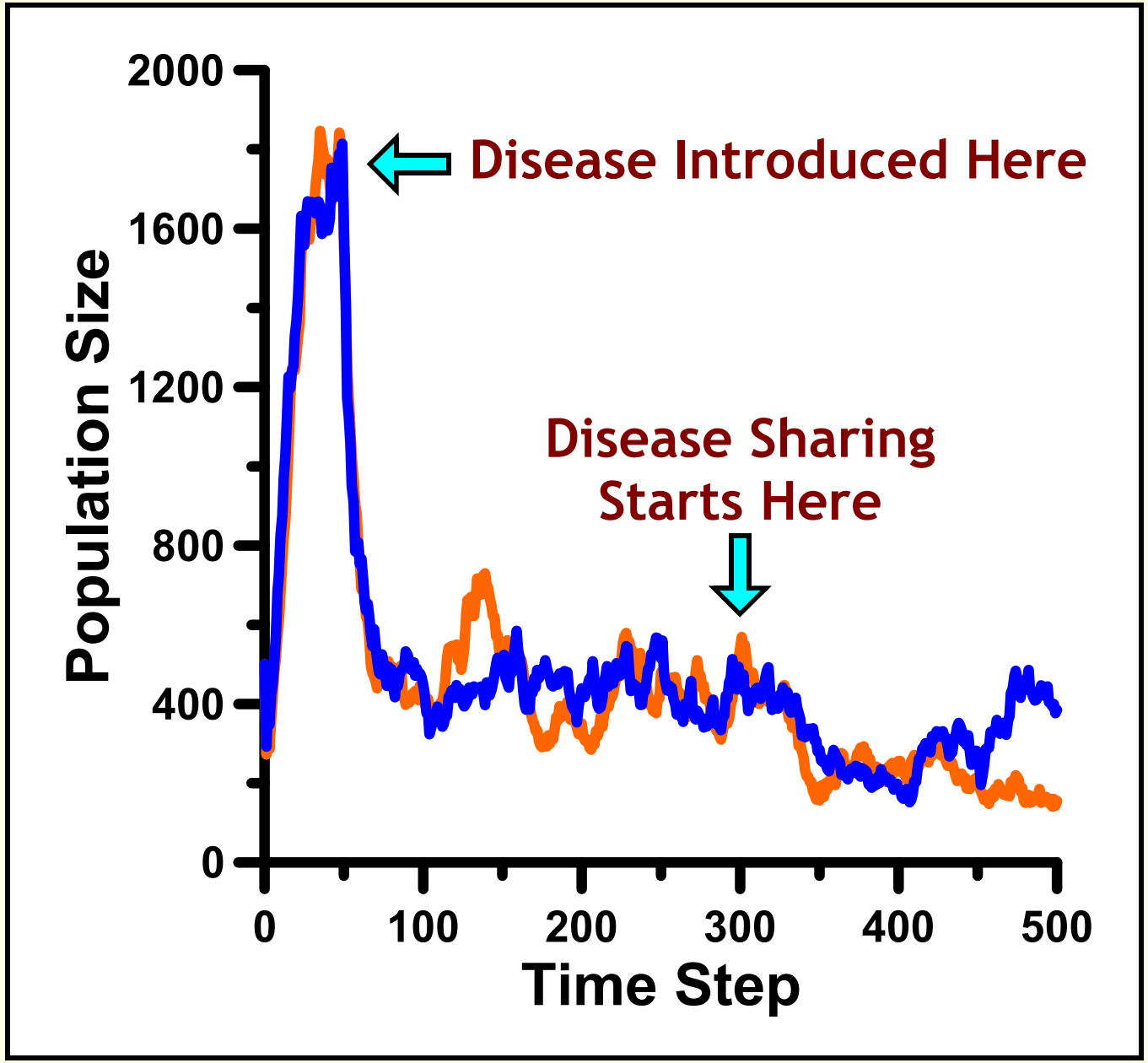
Disease + Competition



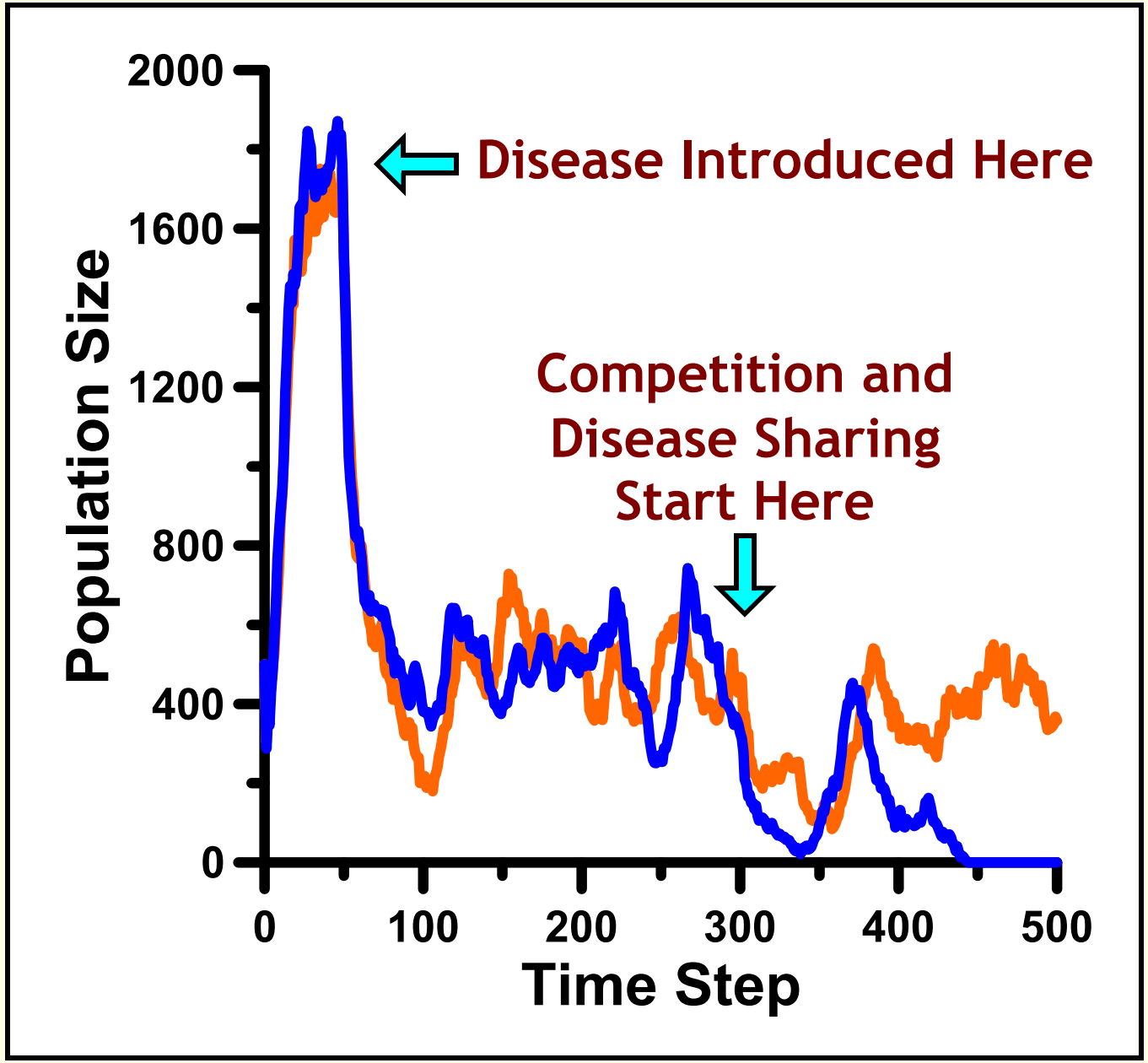




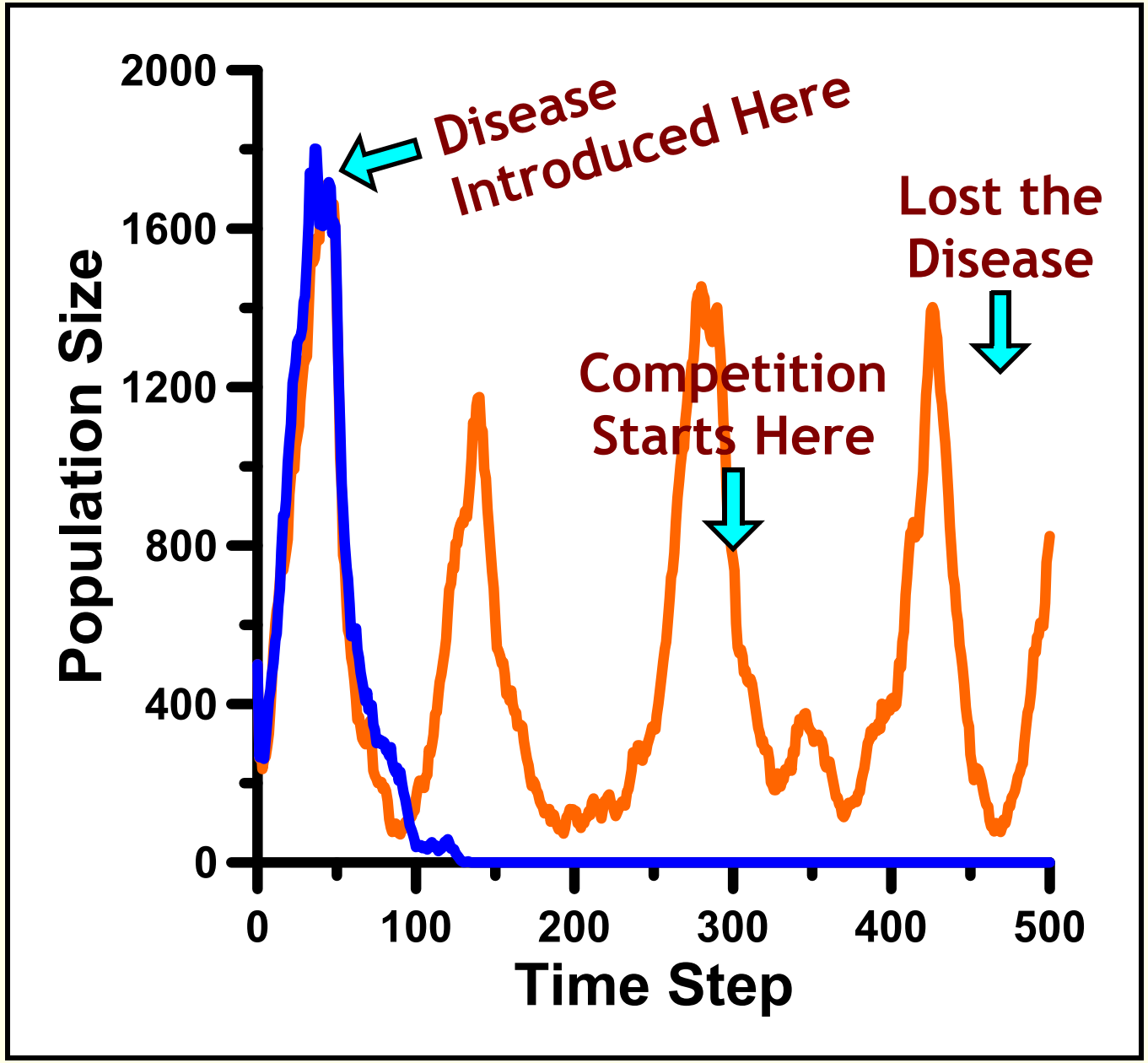
Disease Sharing [No Competition]



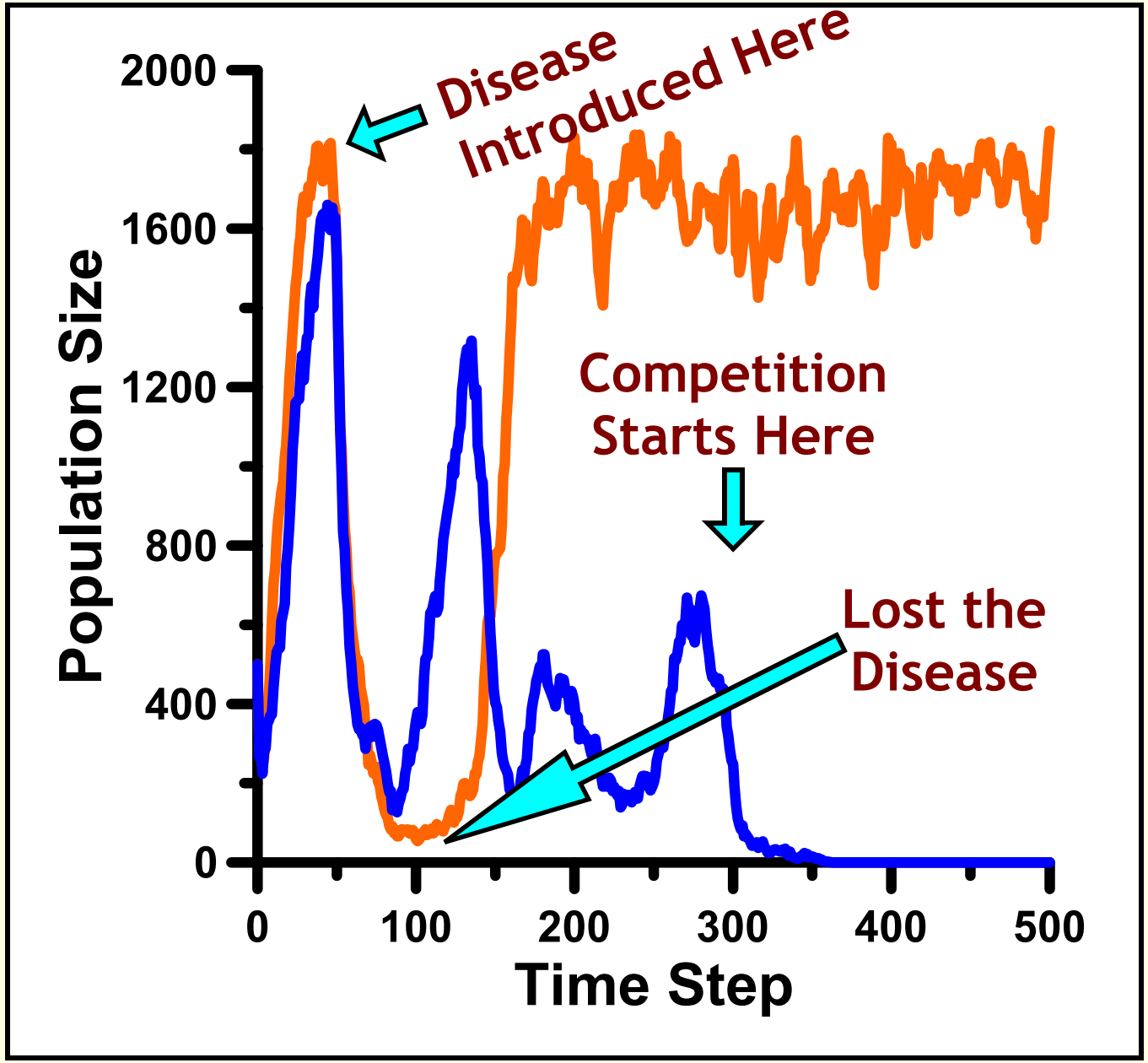
Competition + Sharing



Disease (not shared) + Competition + Beneficial Disturbance [1]



Disease (not shared) + Competition + Beneficial Disturbance [2]



Conclusions

- We have developed a flexible system for evaluating stressor interactions.
- Individual variation through traits is most important element of our design.
- This proof of concept illustrates a little of what can be done with the tools. Your use of these tools is encouraged.

Acknowledgements

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www.epa.gov/hexsim
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